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**U.S. Army  
Environmental  
Center**

## **U.S. ARMY ENVIRONMENTAL CENTER**

### **WOODBIDGE RESEARCH FACILITY REMEDIAL INVESTIGATION/FEASIBILITY STUDY**

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**Sampling and Analysis Plan  
Vol I: Field Sampling Plan  
Vol II: Quality Assurance Project Plan  
Addendum 1**

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**FINAL DOCUMENT**

**September 1996**

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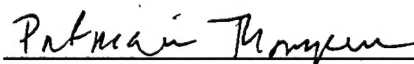
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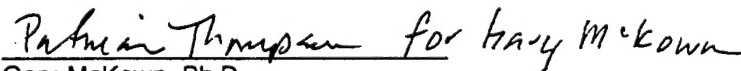
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13. ABSTRACT (Maximum 200 words) U.S. Army Woodbridge Research Facility (WRF) was used in the past as a major military communications center and a research and development laboratory where electromagnetic pulse energy was tested on military and other equipment. WRF is presently an inactive facility pursuant to the 1991 Base Realignment and Closure list. Past investigation activities indicate that polychlorinated biphenyl compounds (PCBs) are the primary chemicals of concern. WRF is presently in the process of being turned over to the United States Fish and Wildlife Service (USFWS) to be used as a wildlife refuge and training facility. This task calls for provision of the necessary staff and equipment to provide remedial investigation/feasibility study support for the USAEC BRAC Program investigation at WRF. This Sampling and Analysis Plan, Addendum 1, Field Sampling Plan presents the sample location and rationale for additional samples required to complete the RI/FS; and the Quality Assurance Project Plan presents any additional data quality objectives and proposed laboratory methods for chemical analysis of samples.				
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SAMPLING AND ANALYSIS PLAN  
VOL I: FIELD SAMPLING PLAN, ADDENDUM 1  
FOR DELIVERY ORDER NO. 0001  
WOODBRIIDGE RESEARCH FACILITY  
REMEDIAL INVESTIGATION/FEASIBILITY STUDY

FINAL DOCUMENT



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SEPTEMBER 1996

## TABLE OF CONTENTS

<b>Section</b>	<b>Page No.</b>
1.0 INTRODUCTION .....	1-1
2.0 SAMPLE LOCATION RATIONALE .....	2-1
2.1 FACILITY BACKGROUND LOCATION RATIONALE .....	2-1
2.2 SAMPLING LOCATIONS FOR PHASE II SAMPLING .....	2-1
2.2.1 AREE 1 - Former Dump No. 1 .....	2-1
2.2.2 AREE 6B - Potential Dump .....	2-4
2.2.3 AREE 20 - Former Incinerator .....	2-5
2.2.4 AREE 22 - Main Drainage Ditch .....	2-11
2.2.5 AREE 39 - Debris Piles .....	2-11
2.2.6 AREE 40 - Former Water Tower .....	2-11
2.2.7 Area Near RI Facility Wide Sediment Sample Location - RISD2 .....	2-12
2.2.8 Area Near Background Monitoring Well MW-63 .....	2-12
2.2.9 Second Round of Water Level Measurements .....	2-17
2.3 DETERMINATION OF BACKGROUND CONCENTRATIONS .....	2-17
2.3.1 Surface Soil .....	2-17
2.3.2 Subsurface Soil .....	2-18
2.3.3 Sediment/Surface Water .....	2-18
2.3.4 Groundwater .....	2-18
2.4 HUMAN AND ECOLOGICAL RISK ASSESSMENTS .....	2-18
2.4.1 Human Health Risk Assessment .....	2-18
2.4.2 Ecological Risk Assessment .....	2-19
3.0 REFERENCES .....	3-1

## LIST OF FIGURES

<b>Figure No.</b>	<b>Page No.</b>
Figure 1-1 Locations of AREEs at WRF .....	1-4
Figure 1-2 Location of AREEs at Main Facility Compound .....	1-5
Figure 2-1 Phase II Proposed Sample Locations .....	2-2
Figure 2-2 Prior and Proposed Sample Locations for AREEs 1, 6B and 7 .....	2-3
Figure 2-3 Prior and Proposed Sampling Locations For AREEs 20 and 40 .....	2-8
Figure 2-4 Facility Wide Potentiometric Map .....	2-16

## LIST OF TABLES

<b>Table No.</b>	<b>Page No.</b>
Table 1-1 Areas Requiring Environmental Evaluation (AREEs) Woodbridge Research Facility .....	1-2
Table 2-1 Results of the RI/FS Round 1 and Round 2 Groundwater Sampling in AREE 6B .....	2-6
Table 2-2 Compounds Detected During Previous Investigations of AREE 20 .....	2-9
Table 2-3 Results of the RI/FS Round 1 and Round 2 Groundwater Sampling at MW-63 .....	2-13

## LIST OF ACRONYMS

Hepta-CDD - 1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin  
Octa-CDD - Octachlorodibenzo-p-dioxin  
AREE - Areas Requiring Environmental Evaluation  
BNAs - Base/Neutral Acids  
bgs - below ground surface  
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act of 1980  
ER-L - Effects Range-low  
ICF KE - ICF Kaiser Engineers  
MCL - Federal Maximum Contaminant Level  
PAHs - Polyaromatic Hydrocarbons  
PCBs - Polychlorinated Biphenyls  
PCTs - Polychlorinated Terphenyls  
RI/FS - Remedial Investigation/Feasibility Study  
RI - Remedial Investigation  
RCRA - Resource Conservation Recovery Act  
RBC - Risk-based concentration  
SVOCs - Semivolatile Organic Compounds  
SI - Site Investigation  
SSI - Supplemental Site Investigation  
TCL - Target Compound List  
TAL - Target Analyte List  
TPH - Total Petroleum Hydrocarbons  
WRF - U.S. Army Woodbridge Research Facility  
VOCs - Volatile Organic Compounds

## **1.0 INTRODUCTION**

ICF Kaiser Engineers (ICF KE) has been contracted by the U.S. Army Environmental Center (USAEC) to conduct a Remedial Investigation/Feasibility Study (RI/FS) for the U.S. Army Woodbridge Research Facility (WRF). WRF is located in Prince William County, Virginia, approximately 22 miles southwest of Washington, D.C. In July of 1991, WRF was recommended for closure by 1991 Base Realignment and Closure Act. The WRF RI/FS will be performed under Contract No. DACA31-94-D-0064, Delivery Order 0001. A Remedial Investigation (RI) was performed at the facility to evaluate the nature and extent of contamination associated with past disposal practices and to evaluate the level of risk posed to human health and the environment.

The Base Closure Team (BCT) has established a total of 41 Areas Requiring Environmental Evaluation (AREEs), which have been investigated during the various field efforts. A list of the AREEs is provided in Table 1-1 and the locations of the AREEs are presented on Figures 1-1 and 1-2.

The preliminary results of the RI indicated that there are limited areas which require follow-up investigations to further evaluate the nature and extent of contamination at the facility. This addendum to the Woodbridge Research Facility, Remedial Investigation/Feasibility Study, Sampling and Analysis Plan, Volume I: Field Sampling Plan, Final Document, February 1996 (USAEC, 1996a) has been prepared to address the additional investigations which will be performed to complete the RI. The goal of the RI is to gather and present information which will allow appropriate risk management decisions to be made regarding evaluation and selection of remedial actions at the facility.

This addendum has been prepared to address only those areas where follow-up investigations are required. The procedures for monitoring well installation, groundwater sampling, surface soil sampling, and sediment sampling will be conducted per the methods outlined in the Woodbridge Research Facility, Remedial Investigation/Feasibility Study, Sampling and Analysis Plan, Volume I: Field Sampling Plan, Final Document, February 1996 (USAEC, 1996a). Analytical methods and quality assurance protocols will adhere to the procedures defined in the Woodbridge Research Facility, Remedial Investigation/Feasibility Study, Sampling and Analysis Plan, Volume II: Quality Assurance Project Plan (QAPP), Final Document, April 1996 (USAEC, 1996d). An addenda to the QAPP has been included in this document to provide and define additional quality assurance elements for the follow-up investigation. Field investigations will be performed under the approved Woodbridge Research Facility, Health and Safety Plan, Final Document, September 1995 (USAEC, 1995b).

**Table 1-1**  
**Areas Requiring Environmental Evaluation (AREEs)**  
**Woodbridge Research Facility**

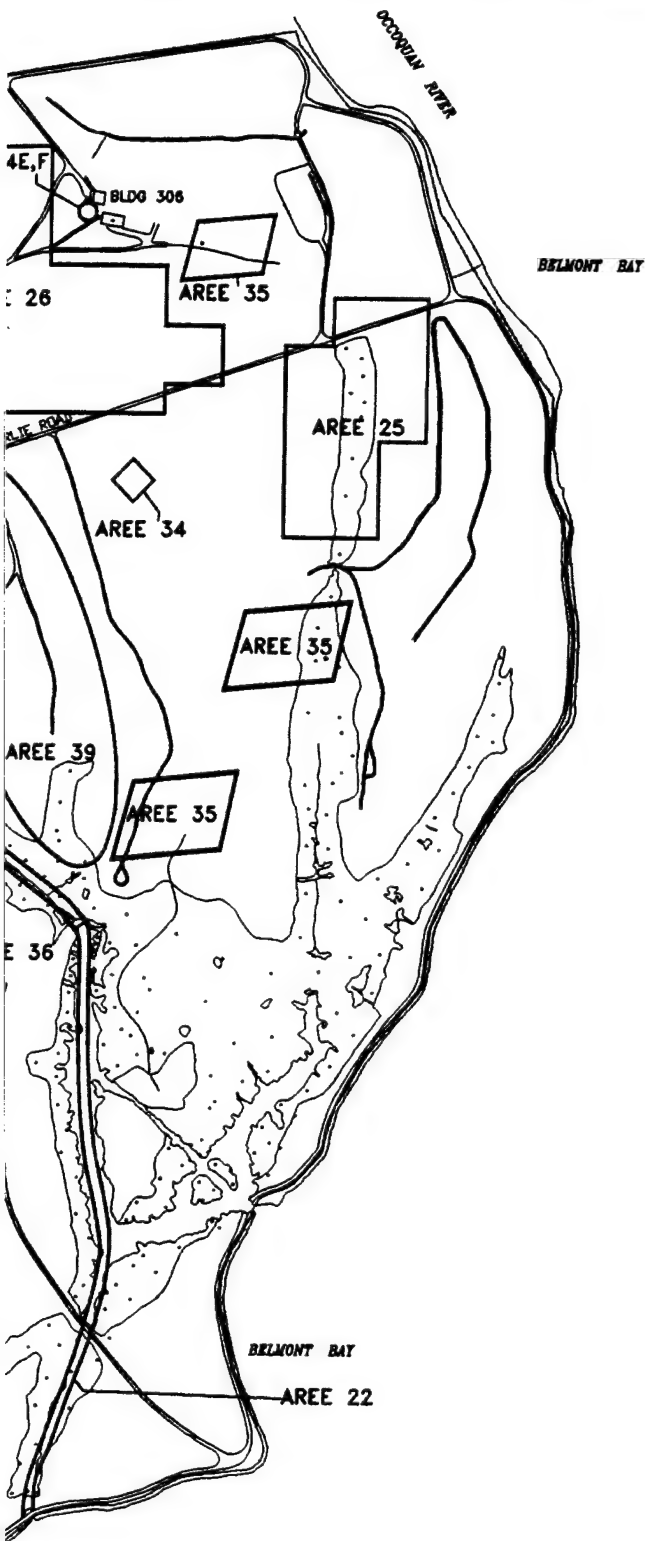
AREE NUMBER	DESCRIPTION	AREE NUMBER	DESCRIPTION
1	Former Dump No. 1	18	Flammable/Battery Storage (Building 204)
2	Former Dump No. 2	19	Thermal Battery Storage
3	Former Dump No. 3	20	Former Incinerator
4	Former Dump No. 4	21	Former Storage Area (Building 211)
5	Former Dump No. 5	22	Drainage Ditch
6A	Former Dump No. 6A	23a	Former 1,000 Gal. UST at Building 101
6B	Former Dump No. 6B	23b	Former 1,000 Gal. UST at Building 202
7	Former Pistol Range	23c	Former 2,000 Gal. UST at Building 203
8	Underground Storage Tank Leaks/Spills at Building 202	24a	Existing 2,000 Gal. Diesel UST at Building 202
9	Salt Contamination at Test Area	24b	Existing 1,000 Gal. Gas UST at Building 202
10	Maintenance Shop (Building 202)	24c	Existing 10,000 Gal. Fuel Oil UST at Building 203
11	Building 202 Drainage Devices	24d	Existing 1,500 Gal. Fuel Oil UST Building 211
12	Drum Storage Area (Building 202)	24e	Existing 300 Gal. Fuel Oil UST at Building 306
13	Acid Neutralization Tank (Building 211)	24f	Existing 300 Gal. Diesel UST at Building 306
14	Oil/Water Separator (Building 211)	25	Sewage Injection Areas
15	PCB Transformer	26	Ethylene Glycol Area
16	Asbestos	27	Buried Wire
17	Petroleum Spill Area (Building 202)	28	Radon



**Table 1-1 (Continued)**  
**Areas Requiring Environmental Evaluation (AREEs)**  
**Woodbridge Research Facility**

AREE NUMBER	DESCRIPTION	AREE NUMBER	DESCRIPTION
29	VEPCO Transformer Spill	35	Former Antenna Field Sites
30	Hydraulic Oil Spill	36	GVF Test Structure
31	Low-Level Radioactive Material	37	Creosote Pole Disposal Sites
32	Lead Paint	38	NVCC Study Area
33	Bulldozer Fuel Spills	39	Debris Piles
34	Hunter Qualification Target Range	40	Former Water Tower
41	Old Homestead Site		

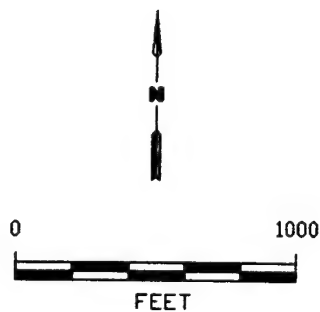




LEGEND

- Road
- Fence
- Swamp

NOTE: AREES NOT DEPICTED DUE  
SITE WIDE NATURE -- AREES 16,  
27, 28, 31, 32 AND 41.



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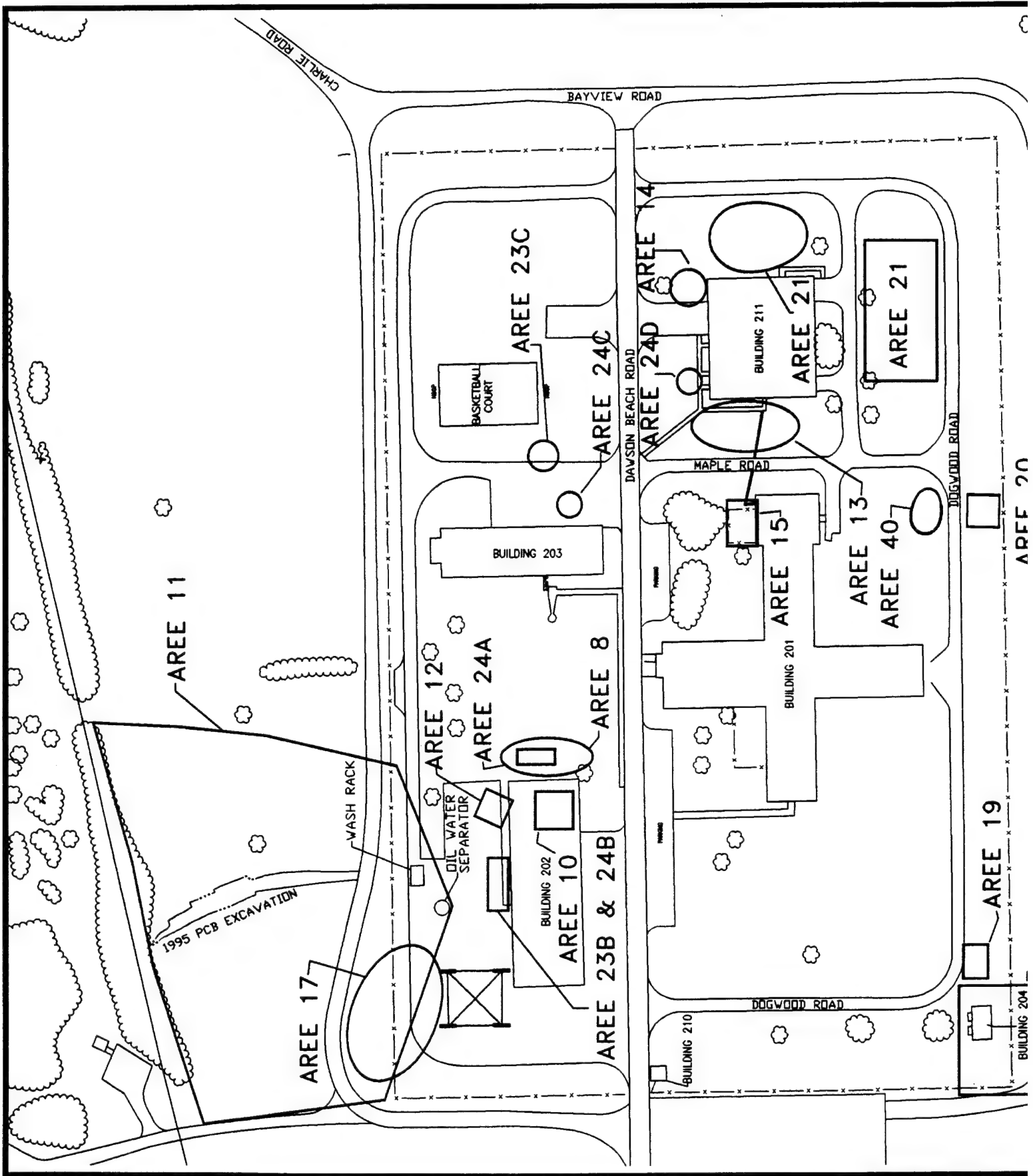
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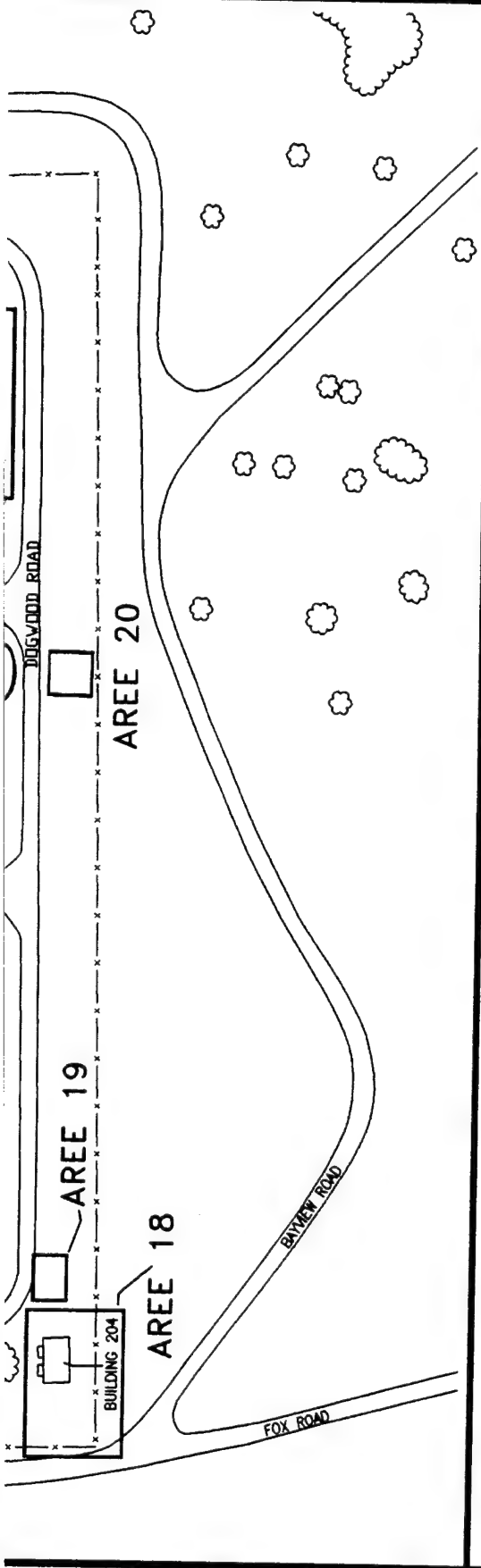
WRFSITMP

FIGURE 1-1

WOODBRIIDGE RESEARCH FACILITY

WRF  
PROPOSED RI  
SAMPLING LOCATIONS





# LEGEND

- TREELINE
- ROADS
- EXCAVATION
- FENCE LINE

AREEs Not Shown:  
 AREE 16 - Asbestos  
 AREE 28 - Radon  
 AREE 31 - Low Level Radioactive Material  
 AREE 32 - Lead Paint



<b>US ARMY</b> <b>ENVIRONMENTAL CENTER</b>		FIGURE 1-2	
		WOODBRIDGE RESEARCH FACILITY	
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## **2.0 SAMPLE LOCATION RATIONALE**

Subsurface soil sampling, surface soil sampling, sediment/surface water sampling, and groundwater sampling was performed at WRF between November 1995 through March 1996 to evaluate the nature and extent of contamination at the facility. This included the installation of four background monitoring wells (MW-52, MW-53, MW-54, and MW-63); five background surface soil samples were collected from locations on WRF; and five background surface water/sediment samples were collected from Mason Neck Wildlife Refuge. To evaluate specific AREEs and evaluate facility wide conditions the following field investigations were performed. A total of 30 shallow and 4 deep monitoring wells were installed; subsurface soil samples and groundwater samples were collected from the soil borings/monitoring wells. Seven soil borings were drilled to evaluate subsurface soil quality where monitoring wells were not warranted. Eleven piezometers were installed throughout the WRF to aid in the development of the facility hydrogeologic model. Test pits were excavated to evaluate geophysical anomalies identified during the 1993 USAEC Site Investigation (SI). Fifty-three surface soil samples were collected to evaluate AREE specific and facility wide surface soil quality, and 45 surface water/sediment samples were collected to evaluate those media. Surface water run-off samples were collected from the former dump areas to evaluate the potential for contaminant transport via run-off from those areas. Staff gauges were installed in selected creeks and ditches to evaluate possible hydraulic connections between the surface water bodies and groundwater at the facility. These activities constituted the Phase I RI site investigation.

To address data gaps identified from the preliminary assessment of the Phase I RI sample results, the following Phase II field activities will be conducted: surface soil sampling, monitoring well installation, groundwater sampling, and sediment sampling. Additional background surface soil samples will be collected and analyzed for dioxins to incorporate these compounds into the background data base.

This section describes the rationale for the selection of locations for further investigation which are based on results of past investigations conducted at WRF. The proposed sampling program has been designed to fill in "data gaps" from previous investigations including the Phase I RI and the Phase II Supplemental Site Investigation (SSI).

### **2.1 FACILITY BACKGROUND LOCATION RATIONALE**

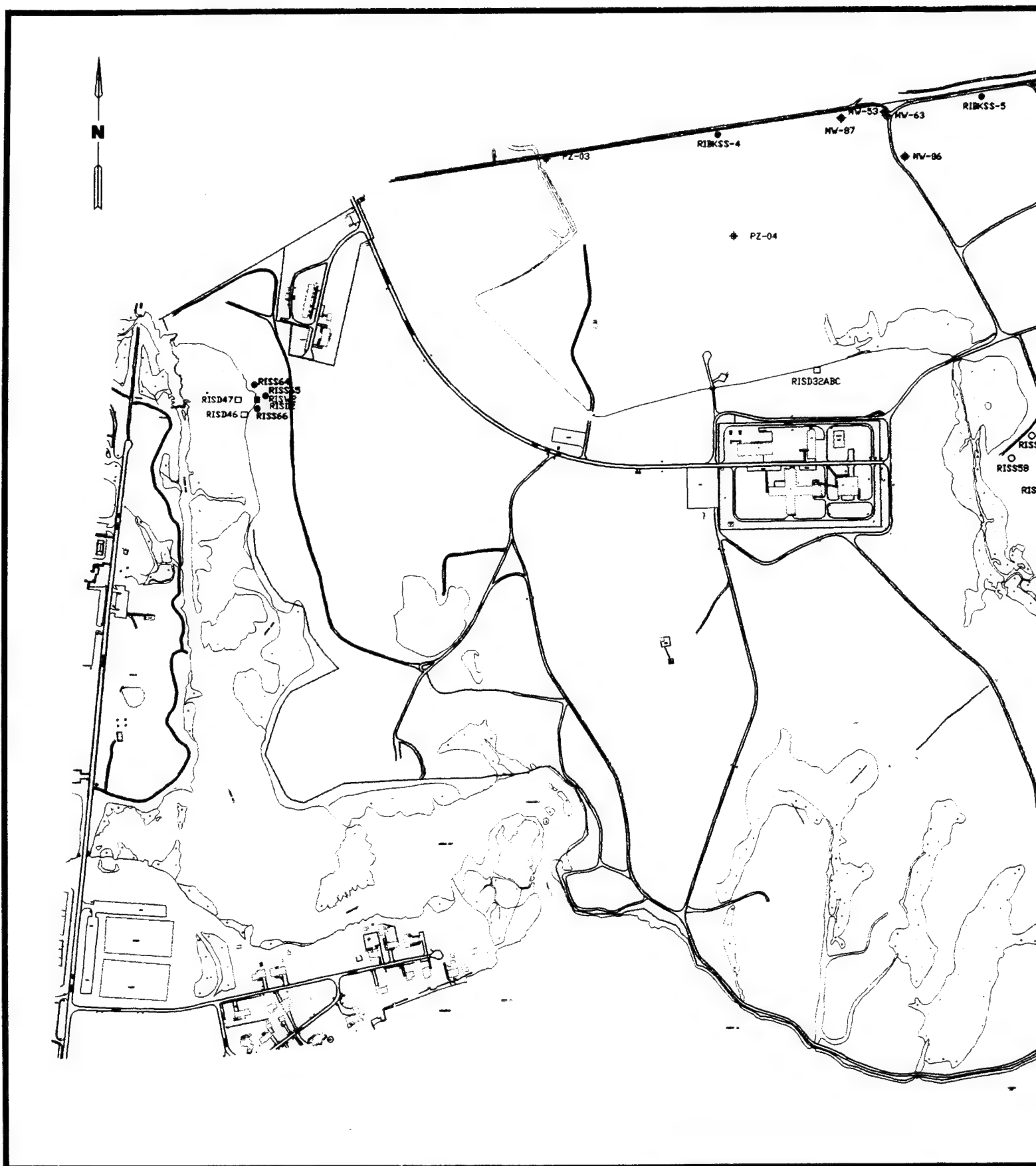
Three surface soil samples will be collected and analyzed for dioxins to establish site background soil levels for these compounds. This data will be used supplement the background data collected for the Phase I RI. The samples will be collected from former Phase I RI locations RIBKSS-3, RIBKSS-4, and RIBKSS-5. The locations of the background surface soil samples are presented in Figure 2-1.

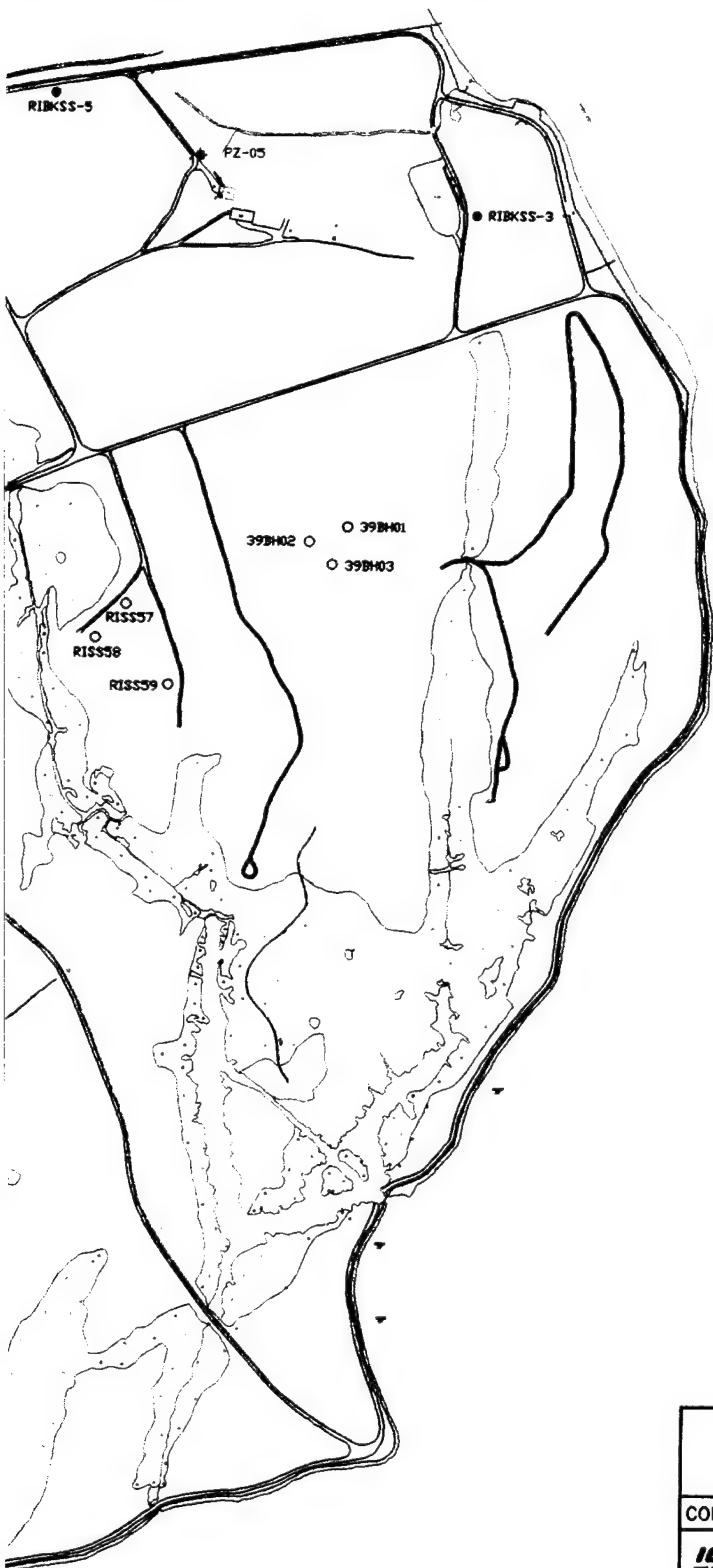
### **2.2 SAMPLING LOCATIONS FOR PHASE II SAMPLING**

This section describes the rationale for further investigations associated with AREE 1, AREE 6B, AREE 20, AREE 22, AREE 39, and AREE 40; additional surface soil and sediment samples proposed to evaluate the area near the RI Phase I sediment sample location R1SD2; and the installation of additional monitoring wells and supplemental groundwater sampling near background monitoring well, MW-63.

#### **2.2.1 AREE 1 - Former Dump No. 1**

AREE 1 is a 0.4-acre former dump site located on the southwest portion of the WRF, and is bordered by Marumsc Creek and the Occoquan Bay. Several sampling events have been performed since 1984 as discussed below. The locations of samples collected from previous investigations are presented in Figure 2-2. An investigation of this AREE was performed by Environmental Science and Engineering, Inc. (ESE) as part of an RI conducted in 1984. The RI results revealed low concentrations of Polychlorinated Biphenyls (PCBs) in sediment (Sample LF1S3). Bis (2- ethylhexyl) phthalate and di-n-octyl phthalate were detected in a surface water sample (Sample LF1W1) collected downgradient from the landfill area. Six monitoring wells, one upgradient (MW-7) and 5 downgradient (MW-8 - 12), were installed as a result of





# LEGEND

- ROAD
- FENCE
- SWAMP
- 39BH01 SSI SURFACE SOIL LOCATION
- RISSV2  
RISSD2 PHASE I SURFACE WATER/SEDIMENT  
SAMPLE LOCATION
- RISS-32 PHASE II SURFACE SOIL SAMPLE LOCATION
- RISSD2 PHASE II SEDIMENT SAMPLE LOCATION
- MW-87 PHASE II MONITORING WELL



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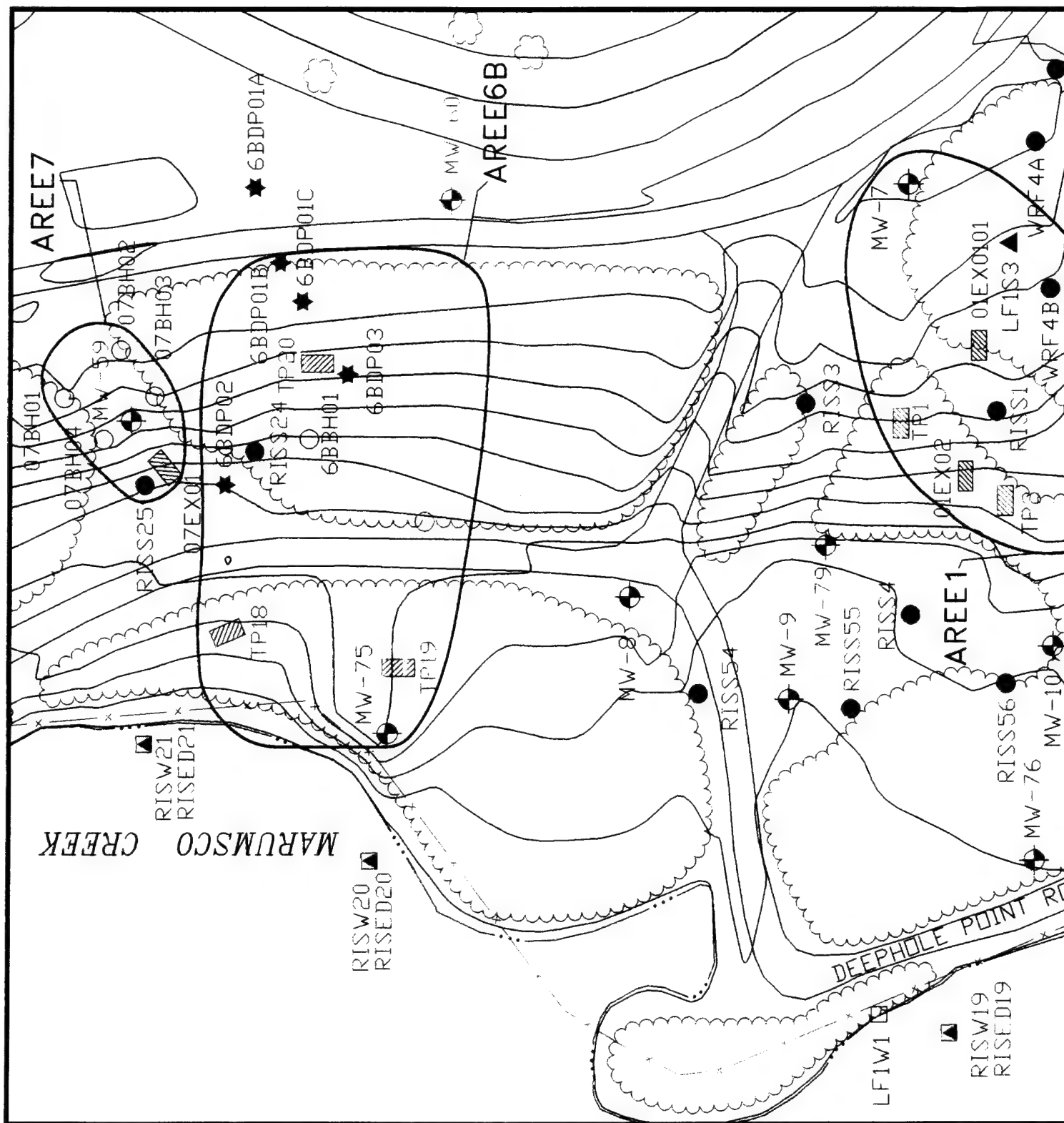
WB\_BASE

FIGURE 2-1

WOODBRIIDGE RESEARCH FACILITY

PHASE II PROPOSED  
SAMPLE LOCATIONS







this investigation. The wells were sampled periodically from 1985 through 1990 and PCBs were detected. The highest concentrations were detected in MW-10 at 2 µg/L. While these concentrations have been reported, the data were suspected of being unreliable and the monitoring program was terminated. Follow-up investigations were conducted in 1993 by the USAEC which included geophysical surveys to locate buried debris, followed by trenching at geophysical anomalies (i.e., areas identified as potential dump sites), and soil sampling in trench locations as well as resampling of the existing monitoring wells. PCBs were detected at 74 µg/g and 31 µg/g from 2 trench samples, 01EX0201 and 01EX0202, respectively, collected from a depth of six feet below ground surface (ft bgs). No PCBs were detected in groundwater. Samples of surface water, sediment, and soil were collected at AREE 1 (sample locations WRF03, WRF03A through WRF03H, WRF04, WRF04A through WRF04H, and WRF10) and the results were reported in the Virginia Department of Environmental Quality's (VDEQ) Bioaccumulation Initiative in Virginia's Coastal Zone Management Area Report (NOAA, 1994). PCBs were detected in sediment, surface water and surface soil. PCB-1260 was detected in sediment samples WRF03E, WRF03F, and WRF03G, at concentrations of 34 µg/g, 26 µg/g, and 6.86 µg/g, respectively. PCB-1254 was detected at 4.7 µg/g in sediment sample WRF03B. PCB-1260 was detected in the following soil samples: WRF04A, WRF04B, WRF04C, and WRF04E at concentrations of 135 µg/g, 180 µg/g, 35 µg/g and 29 µg/g, respectively. PCB-1260 was detected in surface water sample WRF03 at a concentration of 15 µg/L.

As part of the Phase I RI field investigations, the following additional work was performed. Five downgradient soil borings/monitoring wells (MW-76, MW-77, MW-78, MW-79, and MW-80) were installed. The existing wells (MW-7 through MW-12) were sampled. Groundwater samples from AREE 1 were analyzed for Target Compound List (TCL) Volatile Organic Compounds (VOCs), TCL Semivolatile Organic Compounds (SVOCs), pesticides/PCBs, Polyaromatic Hydrocarbons (PAHs), Target Analyte List (TAL) metals, and Polychlorinated Terphenyls (PCTs) to further characterize groundwater. Subsurface soil samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PCTs.

Four surface soil samples (RISS-1 through RISS-4) were collected to characterize the extent of surface soil contamination. One surface soil sample (RISS-1) was collected from an area where a drum is protruding from the side of the hill. The remaining samples were collected from areas where stressed vegetation has been observed or in run-off areas. Soil samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and PCTs.

Two test pits (TP1 and TP2) were excavated upgradient and downgradient, respectively, of the two trenches (Trenches 20 and 21) previously excavated and sampled during the 1993 USAEC SI to determine the extent of PCB contamination. Two soil samples were collected from each test pit and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PCTs.

Four surface water run-off samples were collected (SWRO1 through SWRO4) in areas where run-off was occurring from AREE 1 to characterize the potential for contaminated soil to affect downgradient areas by leaching and subsequent transport via surface water run-off. These samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, PAHs, TAL metals, and PCTs.

**2.2.1.1 Phase II Soil Sampling.** During the Phase I field investigations, additional areas were identified where debris is protruding from areas at AREE 1. Three additional surface soil samples will be collected (RISS-54, RISS-55, and RISS-56) to evaluate the surface soil quality in these areas. The sample locations are presented in Figure 2-2. The samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, PAHs, TAL metals, and PCTs.

#### **2.2.2 AREE 6B - Potential Dump**

A geophysical survey was conducted at AREE 6B during the 1993 Site Investigation (SI), with supplemental trenching and soil sampling. No debris was identified during trenching activities; therefore, no samples were collected for chemical analysis. A supplemental investigation of the AREE was conducted and a soil boring was drilled and sampled. Total Petroleum Hydrocarbons (TPH) were detected in soil samples collected from soil boring 06BH01 at depths of 0.5 to 1.5 ft bgs and 4.5 to 5.5

ft bgs at concentrations of 28 mg/kg and 61.4 mg/kg, respectively (USAEC, 1995a). The sample locations are presented in Figure 2-2. Neither the source nor extent of TPH contamination are known at this time.

During Phase I of the RI, one soil boring/monitoring well (MW-60) was installed upgradient of this AREE (which is also upgradient of AREE 7) to evaluate groundwater quality. A soil boring/monitoring well, MW-75, was installed downgradient from AREEs 6B and 7 to evaluate groundwater quality and subsurface soil conditions in this area. Groundwater samples were analyzed for TCL VOC, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH. Two surface soil samples were collected for site characterization (RISS-24 and RISS-25) and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH. Two test pits (TP18 and TP19) were excavated to investigate and characterize metal debris found in an area west of Deephole Point Road within AREE 6B. An additional test pit (TP20) was excavated east of Deephole Point Road to investigate a suspected disposal area where TPH was detected during the 1993 SI. Two soil samples were collected from each test pit and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, PCTs (in samples where PCBs were detected), TAL metals, and TPH.

Iron was the only inorganic detected in groundwater samples collected from AREEs 6B and 7 at concentrations greater than the USEPA Region III tap water Risk Based Concentration (RBC) (1,100 µg/L). The maximum iron concentrations (from both rounds of sampling) ranged from 3,470 µg/L in MW-60 to 2,770 µg/L in MW-75.

Organic compounds, primarily PAHs and pesticides, were detected in groundwater samples collected from monitoring wells installed in this area during the first round of sampling. The following compounds were detected in the groundwater sample collected from MW-60: 2-methyl naphthalene at 2.48 µg/L, DDE at 0.024 µg/L, DDT at 0.019 µg/L, endosulfan sulfate at 0.027 µg/L, endosulfan II at 0.021 µg/L, fluoranthene at 0.034 µg/L, gamma chlordane at 0.008 µg/L, and heptachlor epoxide at 0.088 µg/L. Several of these compounds exceeded either the Virginia Water Quality Standard, the Maximum Contaminant Level (MCL), and/or the RBC. No organics were detected in the groundwater sample collected from MW-75 during the first round of sampling.

During the second round of sampling, no organics were detected in the groundwater sample collected from MW-60. Only one organic compound, DDD, was detected at a concentration of 0.006 µg/L in the groundwater sample collected from MW-75 during the second round of sampling. The detected concentration of DDD was less than its RBC.

The sample locations are presented in Figure 2-2, and the results of the RI/FS round 1 and round 2 groundwater sampling events are summarized in Table 2-1.

**2.2.2.1 Phase II Groundwater Sampling.** One confirmatory groundwater sample will be collected from monitoring well MW-60 to evaluate groundwater quality and substantiate that these compounds are not present. The groundwater sample will be analyzed for TCL pesticides and PAHs.

### **2.2.3 AREE 20 - Former Incinerator**

An incinerator located in AREE 20 was used from the 1950's until 1970. The ash was periodically removed from the stack and it was drummed and disposed of at one of the on-site landfills. The incinerator was dismantled in 1972 and disposed of at Landfill No. 1 (USAEC, 1996). The area was investigated during the Phase II SSI. Four surface soil samples were collected and analyzed for TCL VOCs, Base/Neutral Acids (BNAs), pesticides/PCBs, TPH, dioxin and TAL metals. Sample locations are presented in Figure 2-3 and the detected compounds are summarized in Table 2-2. Octachlorodibenzo-p-dioxin (Octa-CDD) and 1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin (Hepta-CDD) were detected in all four samples collected. In addition to dioxins, pesticides, PAHs, and xylenes were also detected in some of the soil samples (USAEC, 1996).

**2.2.3.1 Phase II Surface Soil Sampling.** The reporting limits associated with the chemical analytical method used during the Phase II SI were greater than the RBCs and therefore dioxins may be

**Table 2-1**  
**Inorganics Detected in Groundwater Samples Collected in AREE 6B**

Sample ID	Aluminum (µg/L)	Barium (µg/L)	Calcium (µg/L)	Iron (µg/L)	Magnesium (µg/L)
Site Background	12,500	107	24,300	9,620	6,830
MW-60 - 1st Round Sampling	2,620	27.5	5,290	3,470	4,960
MW-60 - 2nd Round Sampling	918	ND	4,170	3,340	3,660
MW-75 - 1st Round Sampling	47.3	ND	4,450	1,440	2,940
MW-75DUP - 1st Round Sampling	55.5	ND	4,390	1,420	2,900
MW-75 - 2nd Round Sampling	133	ND	3,250	2,770	2,910

Sample ID	Manganese (µg/L)	Potassium (µg/L)	Sodium (µg/L)	Zinc (µg/L)
Site Background	354	14,000	41,300	46.0
MW-60 - 1st Round Sampling	281	1,560	13,200	ND
MW-60 - 2nd Round Sampling	215	733	8,860	ND
MW-75 - 1st Round Sampling	139	997	10,400	22.9
MW-75DUP - 1st Round Sampling	138	1,060	10,200	ND
MW-75 - 2nd Round Sampling	117	1,200	9,440	ND

Groundwater samples collected from AREE 6B were analyzed for TCL VOCs, SVOCs, Pesticides/PCBs, TAL metals, PAHs, PCTs (for samples in which PCBs were detected), and TPH.

ND – Not detected

MCL – USEPA Maximum Contaminant Level.

– No value available.

<sup>a</sup> Virginia Water Quality Standard.

**Table 2-1 (Continued)**  
**Organics Detected in Groundwater Samples Collected in AREE 6B**

Sample ID	2-Methyl Naphthalene (µg/L)	DDE (µg/L)	DDD (µg/L)	DDT (µg/L)
MCL	—	—	ND	0.001 <sup>a</sup>
MW-60 1st Round Sampling	2.48	0.024	ND	0.019
MW-60 - 2nd Round Sampling	ND	ND	ND	ND
MW-75 - 1st Round Sampling	ND	ND	ND	ND
MW-75DUP - 2nd Round Sampling	ND	ND	ND	ND
MW-75 - 2nd Round Sampling	ND	ND	.006	ND

Sample ID	Endosulfan Sulfate (µg/L)	Endosulfan II (µg/L)	Fluoranthene (µg/L)	Gamma-Chlordane (µg/L)	Heptachlor Epoxide (µg/L)
MCL	—	—	—	0.01 <sup>a</sup>	0.001 <sup>a</sup>
MW-60 - 1st Round Sampling	0.027	0.021	0.034	0.008	0.088
MW-60 - 2nd Round Sampling	ND	ND	ND	ND	ND
MW-75 - 1st Round Sampling	ND	ND	ND	ND	ND
MW-75DUP - 1st Round Sampling	ND	ND	ND	ND	ND
MW-75 - 2nd Round Sampling	ND	ND	ND	ND	ND

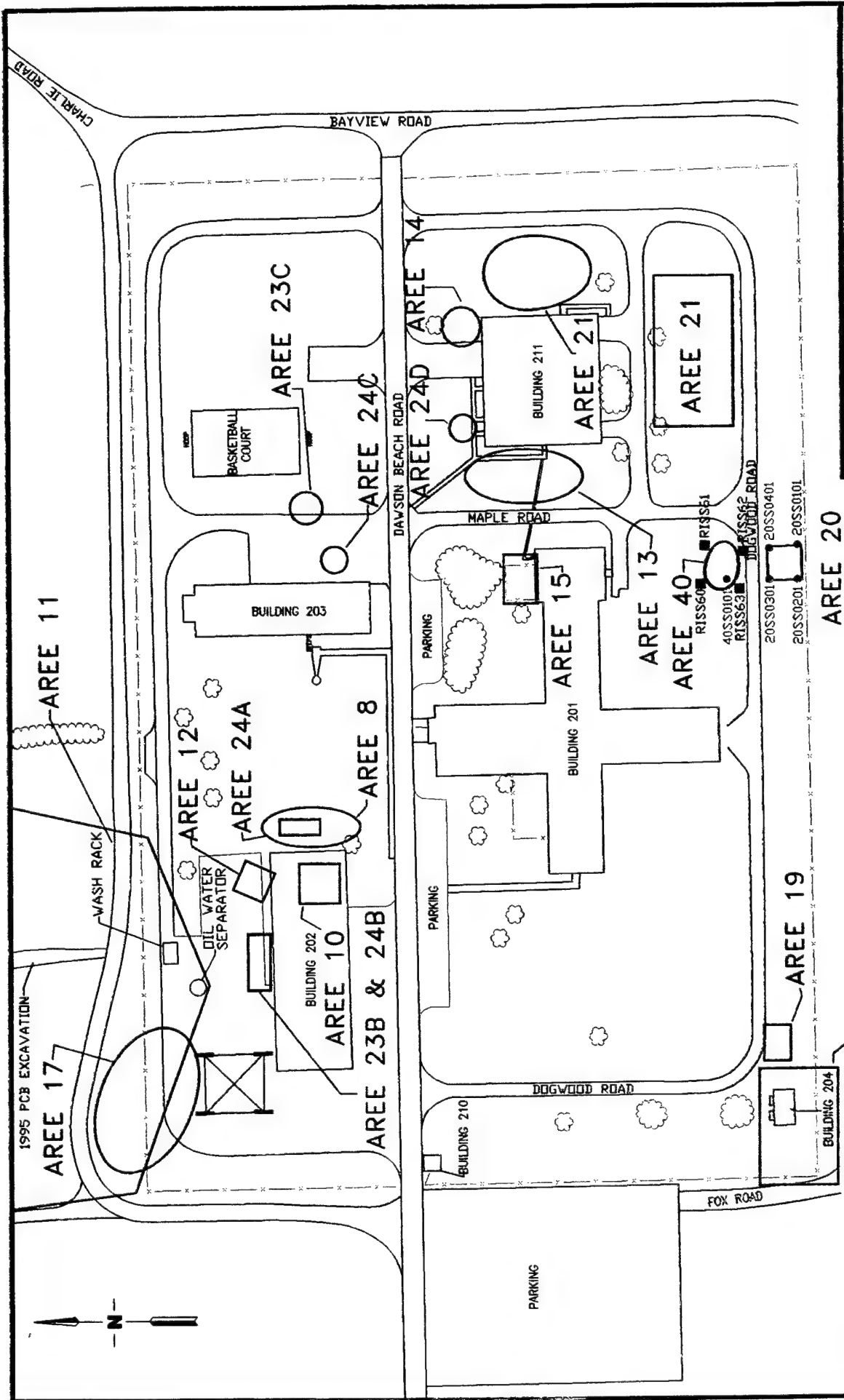
Groundwater samples collected from AREE 6B were analyzed for TCL VOCs, SVOCs, Pesticides/PCBs, TAL metals, PAHs, PCTs (for samples in which PCBs were detected), and TPH.

ND — Not detected.

MCL — USEPA Maximum Contaminant Level.

— No value available.

<sup>a</sup> Virginia Water Quality Standard.





**Table 2-2**  
**Inorganic Compounds Detected in Surface Soil Samples**  
**Collected from AREE 20 for the Phase II SSI**  
**(Results in µg/g)**

Compound	Detection Limit	Background Range	USGS Range	20SS0101	20SS0201	20SS0301	20SS0401	20SS0411 <sup>(1)</sup>
Aluminum	10.7	8,800-14,000	50,000-100,000	14,000	6,200	11,000	12,000	11,000
Antimony	82.9	ND	<1	ND	ND	ND	ND	ND
Arsenic	0.2	1.77-3.33	2.6-6.5	1.88	1.98	2.22	2.5	2.01
Barium	4.87	55.4-100	300-700	109	58.9	98.4	105	102
Beryllium	0.25	0.572-0.858	<1	0.996	0.565	0.842	0.954	0.841
Cadmium	0.427	ND	ND	0.95	ND	ND	ND	ND
Calcium	109	38.1-1,720	3,500-5,200	1420	806	1460	1020	962
Chromium	0.974	19.6-23.9	30-70	29.4	12.7	24.3	28.8	28
Cobalt	2.5	ND-13.8	3-7	12.8	4.01	10.5	12.8	10.7
Copper	3.38	5.62-11.2	20-30	17.4	5.55	14.3	17	19
Iron	12	16,000-20,000	20,000-50,000	24,000	10,000	20,000	26,000	25,000
Lead	0.7	14.2-22.8	15-150	49.5	39.3	44	23.7	23.2
Magnesium	138	1,120-1,790	20,000-50,000	1,940	922	1640	1,620	1,620
Manganese	0.511	93.9-300	200-300	870	410	800	1,000	980
Mercury	0.087	ND	0.082-0.13	9.5	0.32	0.23	0.63	0.63
Molybdenum	4	ND	<3	ND	ND	ND	ND	ND
Nickel	7.5	ND-9.62	10-20	13.3	ND	10.3	11.2	11.2
Potassium	142	408-628	6,800-16,000	1,060	267	495	894	990
Selenium	12.4	ND	0.1 - 5	ND	ND	ND	ND	ND
Sodium	50	ND-106	500-2,000	ND	ND	ND	ND	ND
Thallium	12.5	ND	ND	ND	ND	ND	ND	ND
Vanadium	2	38.1-49.2	70-150	60.1	26.5	54.1	67	64
Zinc	4	37.4-43.6	28-74	109	43.4	74	59.1	57.6

USGS = U.S. Geological Survey  
ND = Not Detected

<sup>(1)</sup> Replicate of 20SS0401.



**Table 2-2 (Continued)**  
**Organic Compounds Detected in Surface Soil Samples**  
**Collected from AREE 20 for the Phase II SSI**  
**(Results in µg/g)**

Compound	Detection Limit	Action Level <sup>(2)</sup>	20SS0101	20SS0201	20SS0301	20SS0401	20SS0411
<b>Dioxins</b>							
Octa-CDD	0.015	-	3.61	4.61	3.87	2.43	ND
1,2,3,4,6,7,8-Hepta-CDD	0.0068	-	0.0802	0.0684	0.0779	0.192	ND
<b>Pesticides</b>							
DDE	0.0142	8.4	0.0567	0.042	0.029	ND	ND
DDT	0.0096	8.4	0.0375	0.02	0.0261	0.154	ND
alpha-chlordane	0.0040	-	ND	ND	ND	0.0068	ND
gamma-chlordane	0.0214	-	ND	ND	ND	0.124	ND
<b>BNAs(includes PAHs)</b>							
Bis (2-ethylhexyl)-phthalate	0.19	200	0.24 <sup>(1)</sup>	ND	ND	ND	ND
Benzo(a)anthracene	0.12	3.9	0.11 <sup>(1)</sup>	ND	ND	ND	ND
Phenanthracene	0.17	-	0.14 <sup>(1)</sup>	ND	ND	ND	ND
<b>VOCs</b>							
Xylenes, total	0.0075	1,000,000	ND	ND	ND	0.0068J	ND

AREE=Areas Requiring Environmental Evaluation

BNA=Base/Neutral Acid

PAH=Polycyclic Aromatic Hydrocarbon

VOC=Volatile Organic Compound

CDD=Chlorodibenzodioxin

ND=Not Detected

J=Estimated

<sup>(1)</sup>Results less than CRL but greater than criteria of detection.

<sup>(2)</sup>USEPA Region III risk-based concentrations soil for commercial locations.

present at concentrations which exceed their RBCs. In order to determine if dioxins are present at concentrations greater than their RBCs, additional surface soil samples will be collected from the same locations previously sampled and analyzed for dioxins using USEPA SW-846 Method 8290. This method can achieve reporting limits for dioxins that are lower than their RBCs. The samples locations are presented in Figure 2-3.

#### **2.2.4 AREE 22 - Main Drainage Ditch**

The results of the Phase I sampling for the RI indicate that PCBs were detected in the sediment samples collected from the Main Drainage Ditch topographically downgradient from the Main Facility Compound where the former washrack and oil/water separator were located. The source of the PCBs is the former washrack and the former oil/water separator. The highest concentration of PCBs detected from the Phase I RI was 6.04  $\mu\text{g/g}$  at sediment sample location RISD32. This sample was collected from 0 to 6 inches below ground surface.

**2.2.4.1 Phase II Sediment Sampling.** In order to determine if PCBs are present in sediments below 6 inches in the ditch (which may affect the remedial options for this area), additional samples will be collected. Three sediment samples will be collected from 6 to 12 inches, 18 to 24 inches, and 30 to 36 inches below ground surface. The sediment sample locations are presented on Figure 2-1 and are shown as sample number RISD32a, RISD32b, and RISD32c. These locations coincide with sediment sample RISD32. The samples will be analyzed for TCL PCBs, grain size analysis, and Total Organic Carbon.

#### **2.2.5 AREE 39 - Debris Piles**

During a facility site walk conducted by the BCT in January, 1995, debris piles consisting of metallic debris, construction material, and unidentified piles of soil were identified south of the Hunter Qualification Range (AREE 34, see Figure 1-1). This area was designated as AREE 39 by the BCT in February, 1995. The location of AREE 39 is presented on Figure 1-1. Samples were collected during the Phase II SI as follows: three surface soil samples were collected and screened for PCBs using PCBs screening kits. No PCBs were detected from the screening tests. Three additional surface soil samples (39BH0101 through 39BH0301) were collected and two subsurface soil samples (39BH0202 and 39BH0302; collected from 3 feet bgs) were collected and analyzed for TCL VOCs, BNAs, PCBs/pesticides, TPH, and TAL metals. DDT and DDE were detected in 4 samples, 39BH0101, 39BH0201, 39BH0202, and 39BH0301. DDT ranged from 0.0184  $\mu\text{g/g}$  in sample 39BH0201 to 0.15  $\mu\text{g/g}$  in sample 39BH0202. DDE ranged from 0.0472  $\mu\text{g/g}$  in sample 39BH0201 to 0.46  $\mu\text{g/g}$  in sample 39BH0301. Styrene and acetone were detected in sample 39BH0101 at concentrations of 0.011  $\mu\text{g/g}$  and 0.026  $\mu\text{g/g}$ , respectively. Benzoic acid was detected in sample 39BH0201 at a concentration of 4  $\mu\text{g/g}$ . Benzoic acid was not detected in the sample collected at 3 feet bgs at the same sample location. The following inorganic compounds were detected above their respective residential RBCs: aluminum, arsenic, beryllium, chromium, iron, manganese, and vanadium (USAEC, 1996).

**2.2.5.1 Phase II Surface Soil Sampling.** Additional debris piles have been identified which require characterization. Therefore, three surface soil samples (RISS-57 through RISS-59) will be collected to evaluate the extent of contamination associated with the debris piles. The samples will be analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PAHs, TAL metals, and TPH. If PCBs are detected then the laboratory will be instructed to analyze for PCTs.

#### **2.2.6 AREE 40 - Former Water Tower**

AREE 40 was established by the Base Closure Team in February, 1995 based on concerns that lead contamination has been associated with water towers at other facilities from paint stripping activities (USAEC, 1996b). This AREE was investigated during Phase II of the SSI. One surface soil sample (40SS0101) was collected and analyzed for TCL VOCs, BNAs, pesticides/PCBs, TPH, and TAL metals. The sample location is presented on Figure 2-3. Lead was detected at 1,450  $\mu\text{g/g}$ , which is significantly higher than the action level for lead (400  $\mu\text{g/g}$ ) as defined by USEPA Revised Interim Soil Lead Guidance

for Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Resource Conservation Recovery Act (RCRA) Corrective Action Facilities (OWSER Directive 9355.4-12). DDT and DDE were detected at 0.0855  $\mu\text{g/g}$  and 0.0525  $\mu\text{g/g}$ , respectively. No other organic compounds were detected (USAEC, 1996).

**2.2.6.1 Phase II Surface Soil Sampling.** Four surface soil samples will be collected on each side of the former water tower site to evaluate the nature and extent of lead contamination. Samples will be analyzed for TAL metals. The proposed sample locations are presented on Figure 2-3.

#### **2.2.7 Area Near RI Facility Wide Sediment Sample Location - RISD2**

Forty five surface water/sediment samples were collected for the RI to characterize facility wide surface water and sediment quality and to use for the Human Health and Ecological Risk Assessments. The samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, PAHs, PCTs, TPH, and TAL metals. Sediment sample RISD2 was collected from a small drainage which discharges into Marumsco Creek along the northwestern edge of the property. The sample location is presented on Figure 2-1. PCB-1260 was detected at a concentration of 0.055  $\mu\text{g/g}$  which is above the ER-L of 0.0227  $\mu\text{g/g}$  for that compound. In addition, several PAHs and pesticides were detected as follows: 2-methylnaphthalene at 0.51  $\mu\text{g/g}$ , acenaphthalene at 2.71  $\mu\text{g/g}$ , anthracene at 0.041  $\mu\text{g/g}$ , benzo(a)anthracene at 0.045  $\mu\text{g/g}$ , benzo(a)pyrene at 0.205  $\mu\text{g/g}$ , benzo(b)fluoranthene at 0.176  $\mu\text{g/g}$ , benzo(g,h,i)perylene at 0.159  $\mu\text{g/g}$ , benzo(k)fluoranthene at 0.087  $\mu\text{g/g}$ , chlordane 0.084  $\mu\text{g/g}$ , dibenzo(a,h)anthracene at 0.035  $\mu\text{g/g}$ , fluoranthene at 0.207  $\mu\text{g/g}$ , gamma-chlordane 0.012  $\mu\text{g/g}$ , indeno(1,2,3-cd)pyrene at 0.099  $\mu\text{g/g}$ , and pyrene at 0.278  $\mu\text{g/g}$  (USAEC, 1996c).

No known disposal areas are located near this sample location and the source for the detected PCB is not known at this time. PAHs and pesticides were detected throughout the facility and therefore, the presence of these compounds is not anomalous.

**2.2.7.1 Phase II Surface Soil Sampling.** Three surface soil samples will be collected to determine the extent of contamination and to determine if there is a source area nearby for the PCBs detected in the sediments. The Phase II surface soil sample locations are presented on Figure 2-1. Soil samples will be analyzed for TCL pesticides/PCBs.

**2.2.7.2 Phase II Sediment Sampling.** Two sediment samples will be collected downstream from sediment location RISD2 to evaluate the extent of contamination in the drainage ditch. The Phase II sediment sample locations are presented in Figure 2-1. The samples will be analyzed for TCL pesticides/PCBs.

#### **2.2.8 Area Near Background Monitoring Well MW-63**

Background monitoring wells MW-53 and MW-63 were installed during the 1995 RI along the northern boundary of WRF. MW-53 is screened from 25 to 35 ft bgs and MW-63, clustered with MW-53, is a deep background well (screened from 40 to 50 ft bgs). The monitoring well locations are presented on Figure 2-1.

The results of the first and second round of groundwater sampling indicate that the groundwater collected from MW-63 has low-level concentrations of benzene, toluene, ethylbenzene, and xylenes (BTEX), PAHs, pesticides, and both diesel and gasoline range TPH compounds. Although MW-53 is clustered with MW-63, the results of first and second round of groundwater sampling indicate that groundwater collected from MW-53 does not contain any of the compounds detected in MW-63 (USAEC, 1996c). The source for these compounds is not known at this time. The results of the first and second round of sampling are summarized in Table 2-3.

A facility-wide potentiometric map has been constructed and is presented in Figure 2-4. The data indicates that groundwater flow in the vicinity of MW-63 is from west/northwest to east/southeast with

**Table 2-3**  
**Inorganics Detected In Groundwater Samples Collected From MW-63**  
**For Round 1 and Round 2 Sampling Events**

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Iron (µg/L)	Lead (µg/L)
MW-63-1st Round Sampling	635	1.60	30.8	ND	24,300	433	ND
MW-63-2nd Round Sampling	780	6.90	30.3	ND	42,800	532	ND
MW-63DUP-2nd Round Sampling	514	6.50	27.2	0.20	41,600	209	1.20

Sample ID	Magnesium (µg/L)	Manganese (µg/L)	Potassium (µg/L)	Selenium (µg/L)	Sodium (µg/L)	Vanadium (µg/L)
MW-63-1st Round Sampling	3,580	12.0	14,000	2.7	41,300	12.3
MW-63-2nd Round Sampling	225	10.8	20,900	ND	44,300	31.4
MW-63DUP-2nd Round Sampling	157	ND	20,300	ND	42,700	28.2

**Table 2-3 (Continued)**  
**Organics Detected in Groundwater Samples Collected from MW-63**  
**For Round 1 and Round 2 Sampling Events**

Sample ID	1-Methyl naphthalene* (µg/L)	2-Methyl naphthalene* (µg/L)	Acenaphthene* (µg/L)	Acenaphthylene* (µg/L)	Acetone (µg/L)	Anthracene* (µg/L)
RBC	1100	1100	1100	1100	3700	1100
MW-63-1st Round Sampling	119	80.5	11.0	6.34	25.0	ND
MW-63-2nd Round Sampling	101	79.3	4.17	3.01	89.0B	2.00
MW-63DUP- 2nd Round Sampling	ND	78.8	8.27	ND	94.0B	ND

Sample ID	BHC,B (µg/L)	BHC,G (Lindane) (µg/L)	Dieldrin (µg/L)	Dimethylphthalate* (µg/L)	Endosulfan, B (µg/L)	Endosulfan sulfate (µg/L)
RBC	1.8	2.4	0.0042	1100	220	220
MW-63-1st Round Sampling	ND	ND	ND	ND	0.021	0.027
MW-63-2nd Round Sampling	0.017	0.098	0.026	ND	ND	0.019
MW-63DUP-2nd Round Sampling	ND	ND	0.018	3.90	ND	ND

Sample ID	Endrin (µg/L)	Ethylbenzene (µg/L)	Fluoranthene (µg/L)	Flourene (µg/L)	Heptachlor (µg/L)	Naphthalene (µg/L)	Phenanthrene (µg/L)
RBC	11	1300	1500	1500	0.0023	1500	1100*
MW-63-1st Round Sampling	0.022	13.0	0.063	3.20	ND	30	8.69
MW-63-2nd Round Sampling	ND	5.30	0.069	1.87	ND	18.0	6.43
MW-63DUP- 2nd Round Sampling	ND	5.20	0.069	2.01	0.11	15.2	6.35

**Table 2-3 (Continued)**  
**Organics Detected in Groundwater Samples Collected from MW-63**  
**For Round 1 and Round 2 Sampling Events**

Sample ID	Pyrene (µg/L)	Toluene (µg/L)	TPH, As Diesel (µg/L)	TPH, As Gas (µg/L)	Xylenes (µg/L)
RBC	1100	750	1 (mg/L)	1 (mg/L)	—
MW-63-1st Round Sampling	0.158	5.20	900	740	54
MW-63-2nd Round Sampling	0.162	2.30	1,140	558	32.0
MW-63DUP-2nd Round Sampling	0.137	2.10	1,130	538	31.0

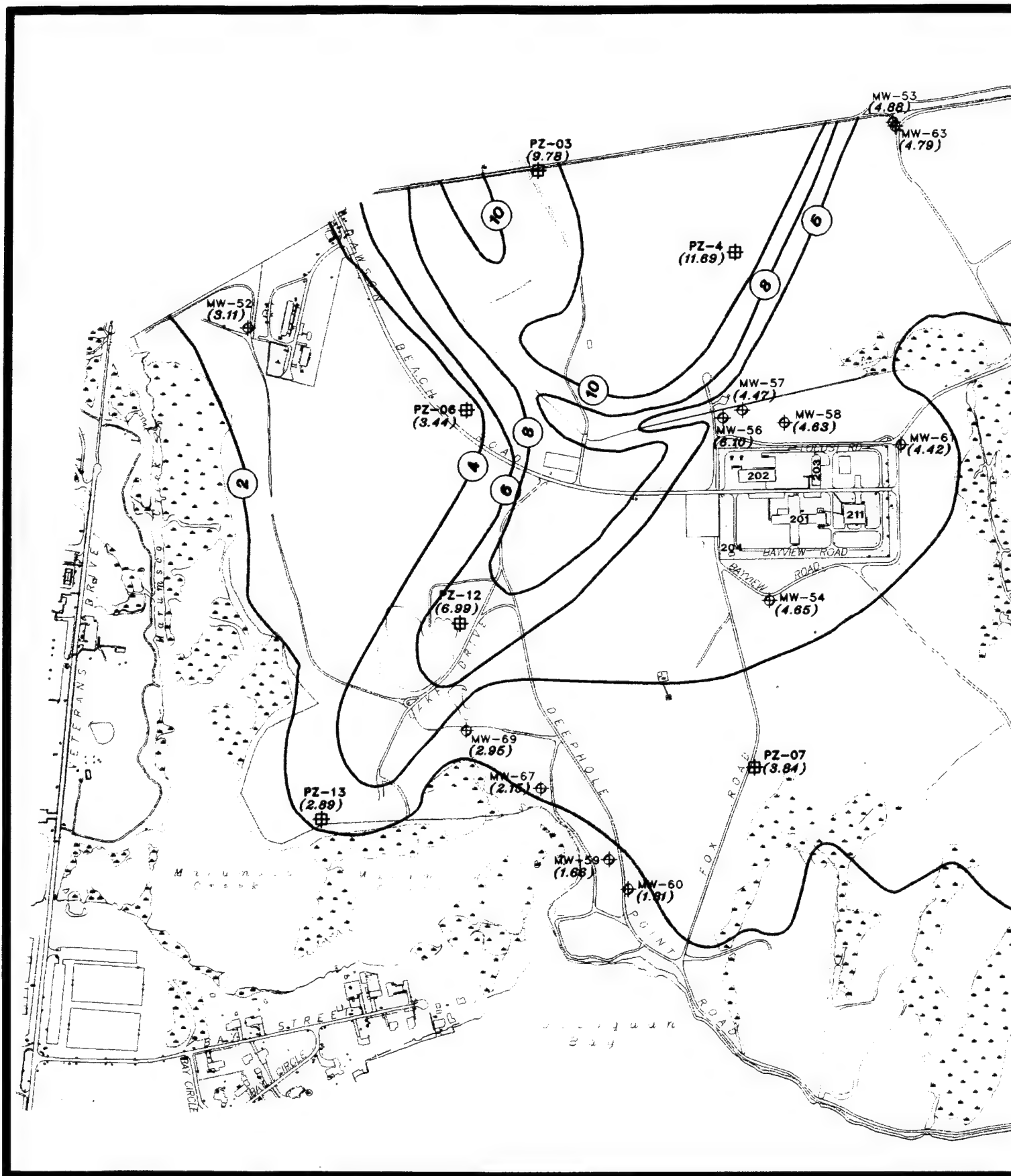
Groundwater samples were analyzed for TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals, PAHs, and PCTs.

ND Not detected.

RBC Risk Based Concentration.

— No value available.

• RBC for Pyrene used.





# LEGEND:

- ROAD
- FENCE
- WATER
- SWAMP
- MW-1 MONITORING WELL LOCATION
- PZ-1 PIEZOMETER LOCATION
- (1.71) WATER LEVEL (FT. MSL)
- WATER TABLE CONTOUR (FT. MSL)

0 600 1200  
SCALE FEET

## US ARMY ENVIRONMENTAL CENTER

CONTRACT NO. DACA31-94-D-0064

◆ ICF KAISER

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PREPARED CST

TASK NO: 66220

CHECKED JPC

ICF DWG NO:

DATE 06-03-96

WRF-IS01

Figure 2-4

WOODBRIE RESEARCH FACILITY

SITOWIDE WATER TABLE  
CONTOUR MAP



groundwater flowing on to the site. This suggests that the source for the contamination in MW-63 is off site. Additional groundwater data is needed to further refine the groundwater flow regime in this area and further evaluate the nature and extent of the contamination.

**2.2.8.1 Groundwater/Subsurface Soil Sampling.** Two additional deep monitoring wells will be installed to evaluate the nature and extent of groundwater contamination in this area. One monitoring well will be installed upgradient of monitoring well MW-63. The second monitoring well will be drilled approximately 250 ft downgradient from MW-63 to evaluate the extent of contamination. The monitoring wells will be installed using mud rotary techniques. In addition, piezometers PZ-3, PZ-4, and PZ-5 will be sampled to supplement groundwater quality information. The subsurface soil and groundwater samples will be analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TPH. Drilling (using mud-rotary), subsurface soil sampling, and groundwater sampling techniques will be consistent with the procedures outlined in the Woodbridge Research Facility, RI/FS, Sampling and Analysis Plan, Volume I: Field Sampling Plan, Final Document, February, 1996.

### **2.2.9 Second Round of Water Level Measurements**

A second round of groundwater levels will be measured to evaluate temporal fluctuations in groundwater elevations for all wells and piezometers on site (including the newly-installed wells).

## **2.3 DETERMINATION OF BACKGROUND CONCENTRATIONS**

A statistical analysis will be performed for all sampled media to determine which chemicals detected on site are within background concentrations. In order to determine if detected levels of compounds present at the site are representative of naturally occurring background levels, on-site data for each medium will be statistically compared to site-specific background data.

The first step of the statistical comparison is to test the site and background data to determine the distribution type of the data sets, using the Shapiro-Wilks test. If the data are normally or log-normally distributed, a two-tailed variance ratio test (the F-test) is performed in order to determine if the variances of the on site and background data sets are similar. If the variances for the two data sets are found to be similar, then the one-tailed pooled variance t-test is considered appropriate to test for similarity between on site and background levels. If on site and background variances are found to differ significantly, or if the data are determined to be neither normally or log-normally distributed, then a nonparametric test (the one-tailed Mann-Whitney test) is used to test for similarity between on site and background levels. All statistical tests are performed using a significance level of 95% ( $\alpha = 0.05$ ) and are described in detail by Zar (1984). Statistical tests for log-normally distributed data are performed using natural log-transformed monitoring data. This methodology will be used for all sampled media to determine which compounds are within background levels. Those inorganic compounds that are considered to be statistically within background levels are generally considered not to be a concern. However, if an inorganic compound is within background but above levels such as the RBC or E-RL, than that compound will be evaluated in the Risk Assessment.

### **2.3.1 Surface Soil**

Five surface soil samples (RIBKSS-1 through RIBKSS-5) were collected during the RI from on site locations that were upgradient and/or unaffected by past site activities. These five background surface soil samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, PAHs, PCTs, TPH, and TAL metals. During the Phase II RI, three additional soil samples will be collected from RIBKSS-3, RIBKSS-4, and RIBKSS-5 and analyzed for dioxins to supplement the background data as described in Section 2.1. The methodology for the statistical analysis discussed above was used to determine which compounds detected on site were within background levels associated with RIBKSS-1 through RIBKSS-5.

### **2.3.2 Subsurface Soil**

Subsurface soil samples were collected from background monitoring wells MW-52, MW-53, and MW-54, which were installed for the RI. The samples were collected from 0 to 2 ft bgs and every 5 ft to the water table. The soil samples collected from these background locations will be grouped into two categories.

The first grouping (which consists of three samples) will be samples collected from 0 to 2 ft bgs. These data will be combined with the five background surface soil samples to bolster the data set for background surface soil. Therefore, a total of eight surface soil samples will be used to statistically determine which site surface soil concentrations are within background levels.

The second grouping from the subsurface soil borings will consist of samples collected at depths below 2 ft bgs. The six samples collected from 2 ft bgs to the water table will be grouped for the purposes of determining which compounds detected in on site samples are within background levels.

### **2.3.3 Sediment/Surface Water**

Five sediment/surface water samples (RIBKSD1 through RIBKSD5 and RIBKSW1 through RIBKSW5) were collected from Mason Neck Wildlife Refuge. The five surface water and the five sediment samples will be used when determining which chemicals detected on site are within background levels.

### **2.3.4 Groundwater**

Two rounds of groundwater samples were collected from shallow monitoring wells MW-52, MW-53, and MW-54, for a total of six samples. These samples will be used to characterize background concentrations for groundwater. In addition, one deep background monitoring well (MW-63) was installed for the RI and based on a review of the water level elevations for deep and shallow wells, it appears that the shallow and deep wells are hydraulically connected. Therefore, the background groundwater data from the six samples can be compared to the deep wells for background analysis.

## **2.4 HUMAN AND ECOLOGICAL RISK ASSESSMENTS**

This section discusses how the human health and ecological risks assessments will be conducted per agreements with the Army and regulatory agencies. A comprehensive discussion regarding the Human Health and Ecological Risk Assessments are presented in the Woodbridge Research Facility, Remedial Investigation/Feasibility Study, Sampling and Analysis Plan, Volume I: Field Sampling Plan, Final Document, February 1996 (USAEC, 1996a) and the Woodbridge Research Facility, Remedial Investigation/Feasibility Study, Work Plan, Final Document, February 1996 (USAEC, 1996b).

### **2.4.1 Human Health Risk Assessment**

In accordance with VDEQ and United States Environmental Protection Agency (USEPA) Region III, residential soil RBCs will be used to screen chemicals in soil and sediment at WRF. As discussed in previous meetings, and as presented in a letter from ICF Kaiser to USAEC dated July 31, 1996, ICF Kaiser will streamline the Operable Unit (OU) risk assessments for the WRF by only evaluating residential exposure scenarios. The premise of only evaluating risks for residential receptors would be that if risks for residents are acceptable (i.e., within the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  risk range), risks for all other receptors also would be acceptable.

#### **2.4.2 Ecological Risk Assessment**

Region III Biological Technical Assistance Group (BTAG) screening levels will be used to identify Chemicals of Potential Concern (COPCs) in all forthcoming ecological risk assessments based on recent discussions with the Region III BTAG. The OU2 ecological risk assessment used an approach previously agreed to by the Region III BTAG to identify COPC.

Tissue residue and sediment data are being summarized in the ecological risk assessments in both normalized and non-normalized forms. However, the form of the data used to ultimately evaluate risk will depend on the receptor/exposure scenario being evaluated. For example, the potential for adverse effects to a piscivorous species will be evaluated using non-normalized data because such data are applicable to the exposure scenario and toxicity values being applied.

### 3.0 REFERENCES

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